TEACHING STYLES

The use of elearning in medical education: a review of the current situation

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Computers are increasingly used in medical education. Electronic learning (elearning) is moving from textbooks in electronic format (that are increasingly enhanced by the use of multimedia adjuncts) to a truly interactive medium that can be delivered to meet the educational needs of students and postgraduate learners. Computer technology can present reliable, reusable content in a format that is convenient to the learner. It can be used to transcend geographical boundaries and time zones. It is a valuable tool to add to the medical teacher's toolkit, but like all tools it must be used appropriately. This article endeavours to review the current ''state of the art2 in use of elearning and its role in medical education alongside non-electronic methods—a combination that is currently referred to as ''blended'' learning.

''Space is big, really big...''—*The Hitch-Hikers Guide to the Galaxy*, Douglas Adams

Medicine comprises a vast collection of knowledge, skills and attitudes. The trainee practitioner must achieve a large number of learning objectives within each of these so-called domains of learning to be considered competent to practice. Once registered, continuing professional development (CPD) is required to maintain and further develop competence. The acquisition of learning objectives in both undergraduate and postgraduate medical education can be achieved by a mixture of modalities including apprenticeship, didactic teaching (lecturing), self study and small group learning. It is clear that some of these teaching tools are better than others at helping the learner achieve his or her objectives. The recent rapid development of information technology has allowed electronic learning or ''elearning'' to obtain a place in the ''teaching toolbox''.

This article endeavours to review the current state of the art in the use of elearning and its role in medical education alongside non-electronic methods—a combination that is currently referred to as 'blended' learning.

THE ACQUISITION OF KNOWLEDGE

Computers are good at storing information. They reproduce it accurately time after time and, with appropriate connections, can transmit that knowledge to where it is needed. At the basic level textbooks can be turned into etextbooks—that is to say, a written page can be viewed on the computer screen. This can be enhanced by hyperlinking text so that a learner could jump to another section or call up a glossary. In an age of learner centredness this is a step toward self direction. The presence of texts, be they undergraduate textbooks or the latest research article, in data repositories linked to form a federation is often all that is required. The busy clinician can now search a virtual database (for example, PubMed or one of the other repositories) for the answer to his or her current clinical problem. The term ''just-in-time'' learning has been applied to this concept. With the appropriate technology (laptop/palmtop computers combined with satellite links/wireless hotspots) this concept of just-in-time learning has been used to support battlefield surgeons and rural practitioners as well as teaching hospital consultants after the latest research information. This integration of learning with practice is often referred to as convergence.

One might use the phrase ''in my own time'' to denote the use of elearning resources by learners when and where they want it (''just for me'' has also been used). An example would be the use of an elearning package for induction of new junior doctors working many different shifts who are unlikely to all meet together. The term ''in my own time'' is double edged and time for elearning, if it is to be used, must be factored into the curriculum.

''A picture paints a thousand words...'' Chinese proverb

As well as simply providing content, the information presented can be enhanced and thus hopefully made easier to assimilate by the use of multimedia. Examples of beneficial multimedia might include a video clip that shows a child with stridor, a ''flash'' animation that demonstrates a cellular process, or a chest *x* ray that highlights and explains the abnormality when the cursor is moved over it. As with all enhancements it is important that they are used appropriately and do not detract from the message the teacher is trying to convey. From the point of view of the

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Abbreviations: CPD, continuing professional development; HTML, hypertext markup language; MCQs, multiple choice questions; RLO, reusable learning object; XML, extensible markup language

elearning ideas

- An induction package based on the eight most common groups of presenting complaints to new residents at a walk in clinic[5]
- An international initiative to develop a standard for virtual patients: http://www.medbiq.org/working_groups/virtual_patient/index.html
- The International Virtual Medical School: http://www.ivimeds.org/
- Some examples of virtual patients
  - http://www.etu.sgul.ac.uk/virtualpatients/examples.htm
  - Web-SP (Web-based Simulation of Patients): http://websp.lime.ki.se/
  - These have been used in examination[6]
- Virtual patients can be used within a ''real-life'' tutorial group with learners working in pairs of threes
- The resources of virtual patients can be used by tutors to augment bedside teaching (for example, you have elicited the clinical signs of a 5-year-old with pneumonia, here is a video of a baby with the same problem; note the difference in the pattern of recession…)
- An example of 'just-in-time' learning – essentially a collection of guidelines: http://www.ucl.ac.uk/medical-school/current-students/learning-resources/Virtual-consulting-room-demo/
- Virtual tutorial groups over the internet. Their use increases with time and, like ''real life'' tutorials, some tutors appear to engender more enthusiasm than others (Peninsula Medical School)[7]
- A teaching package for rural family practitioners. The group watch a presentation on CD-ROM and then have a 15 minute interaction with an ''expert'' by web-conference[8]
- Get your students to do it! They are probably much more computer literate than you. Perhaps you could pay for their IT training as was done at Cairo University[9]
- Some detailed on-line text based cases that allow selection of investigations and provide good feedback: http://cpsc.acponline.org/free-cpsc/index.html

educator the logical conclusion of this movement from passive reading to active media is true interactivity.

LEARNING SKILLS

> ''Lessons in the practical arts demand the presence and help of a master.'' Collectanae, Pietro Monte, 1509 AD

Psychomotor (physical) skills are best learned by doing them. Most of these cannot be learned from a computer. However, elearning can be used to aid the teaching of physical skills. A video showing the technique, or a package explaining the theory and putting it into context, could prime learners before they attend the teaching session. It could certainly be used to deliver stages 1 and 2 of the widely used ''4 stage'' technique.

One area that has generated interest in medical education is the ''virtual patient''. The term is used somewhat loosely to cover what some might call ''multimedia enhanced'' patients. Examples might include a video of a consultation to demonstrate history taking or an examination technique, or a written case with pictures (a rash)/video (gait)/audio (heart sounds) to demonstrate a physical sign. Such use of the technology clearly has its place, allowing the learner to develop skills away from the bedside or perhaps in areas where contact with certain pathologies is limited (for example, the student studying paediatrics in the summer might not see bronchiolitis, six weeks on cardiology might not equip one to deal with rectal bleeding, etc).

Beyond this lies the development of virtual patients to help teach the skills of diagnostic reasoning and patient management through true interactivity. Some packages allow the student to take a virtual history using a bank of questions and examine the virtual patient. This may have a place but it is difficult to envisage how pointing and clicking on a stethoscope then dragging it to the patient's chest to listen to a virtual heart will be of much benefit. Such skills are probably best learnt along with other psychomotor skills at the bedside or in the simulator. However, presentation of a clinical scenario that then allows the student to consider diagnosis, investigation and management is perhaps a better use of the resources. Good models allow a number of choices, more than one of which may be correct, at each ''node''. An appropriate choice allows the learner to move to the next node and thus proceed with the case—for example, options for the management of a child presenting with abdominal pain might include ''wait and see'', ''trial of treatment'' and ''investigation''. Guidance can be included at each step in the form of a ''help'' function, access to appropriate texts/algorithms, a formulary to look up drugs or even a glossary to explain terms. The level of support (scaffolding) can be varied according to the seniority/skill of the learner and perhaps removed (disabled) entirely if the scenario is being used for testing purposes. For example, a trainee who elects to discharge a lethargic infant with a pyrexia might be advised by a virtual senior that the child should be admitted for investigation and treatment; a more senior learner might be told to admit the patient and then be called back later because of nursing concern; someone who should know better may be called back to ''resus'' 4 h later or to the coroner's court! This is approaching ''simulation'' which, in this context, means a model that the learner can play with to see what happens. In many disciplines computer simulations are mathematical. In clinical medicine, however, aside from a few endocrine problems and perhaps some conditions that can be managed by a strict protocol (perhaps asthma), all possible choices and outcomes must be considered and included by the case writer. The development of such cases is thus very time consuming and interactivty is still limited by the imagination of the subject expert writing the case and, to some degree, by the content engineer who programmes it.

DEVELOPING ATTITUDES

Attitudes are probably most developed by human interaction although the principles on which they are based can be learned (and hence, if necessary, taught by an elearning ethics or diversity course). In this section I would like to explore the possibilities for ''human'' contact using information technology.

If I am unsure how to act I may speak to a colleague or I may phone a specialist. More forms of interaction are also possible using information technology. I am a member of a Yahoo discussion group on paediatric allergy. If I am stuck with a case

Glossary

- Accessibility: the ability to access content by a wide range of users
- Asynchronous communication: separated in time (for example, a blog or email)
- Blended learning: the mixture of non-elearning and elearning
- Blog (short for ''weblog''): the writer (the teacher) can lead the discussion/set problems; users (the learners) can post comments
- Browser: a computer programme that accesses web pages (for example, Internet Explorer, Netscape Navigator)
- Convergence: the blending of classroom teaching to workplace practice
- Domains of learning: knowledge, skills and attitudes
- Data repository: a computer on which information (learning content) is stored
- Durability: the ability to store and access content over time
- Elearning: education using electronic media
- Federation: a linkage of data repositories that allows users to access information
- Flash: a series of programmes used to create and display short graphical sequence (for example, cartoon) that can be used to enhance a web page
- Format: the way content is stored (ideally in a standard way, separated from presentation, to allow RLOs to be easily accessible, interoperable and durable)
- Formative assessment: assessing a learner as he/she progresses through the course in order to improve their performance
- Four-stage technique for teaching psychomotor skills: a stepwise approach to teaching practical skills: (1) the teacher demonstrates; (2) the teacher demonstrates with commentary/explanation; (3) a learner commentates while the teacher demonstrates; (4) the same learner talks through the skill while performing it. Supported practise should then follow.
- HTML: hypertext markup language—the basic code in which most web pages are written
- Hyperlink: a highlighted (usually underlined) word, phrase or picture that allows the user to jump from one part of an electronic document to another
- Interoperability: the ability to transfer content from one platform to another (for example, palmtop, laptop, PDA)
- Just-in-time learning: the ability for the learner to access information needed when it is needed
- Learner centredness: a model of education in which education resources are available specifically to suit the needs (and often wants) of the student (cf teacher centredness in which the students' needs are subservient to those of the teacher)
- Just-for-me learning: what I want, when I want it, how I want it!
- Platform: the equipment used to access content—for example, laptop, desktop, palmtop, mobile phone
- Reusable learning object (RLO): a piece of subject content that can be accessed from a variety of elearning packages
- Scaffolding: the support given to a self-directed learner—ideally this should be reduced with progress through the course
- Simulation: in the elearning context this refers to a computer based model in which the learner can test ideas; models usually have a mathematical basis and are this not often used in the context of medical education
- Summative assessment: a pass/fail test (usually at the end of the course)
- Virtual patient: a computer based model of a patient (real or fictitious)
- wiki: a website that anyone can edit
- XML: extensible markup language—an industry standard for storing data

I post a question and someone will come back to me. Similarly if I have encountered a scenario before about which someone posts a question I can share my experiences with other users. I am alerted to all postings by email. Clearly some of this is likely to be ''consensus-based'' rather than evidence based, but when there is no randomised trial one must move down the hierarchy of evidence until one reaches expert opinion. Similar groups exist in other disciplines. A similar approach has been used with problem based learning groups, allowing students to paste comments on a ''blog'' or edit a ''wiki''. This form of communication is referred to as ''asynchronous'' and, of course, takes time for a response to come.

''Synchronous'' communication is also possible. As a generalist, I frequently phone specialists for advice ''just in time''. In the training context it is becoming reasonably common to use web conferences to link undergraduate lectures or to demonstrate surgical techniques live in virtual workshops. In Canada, geographically isolated practitioners can take part in web conferencing with a specialist after or even during an elearning CPD tutorial. Chat rooms offer the possibility of a different form of communication; although it is difficult to see what advantage they confer over voice communication, my son ''chats'' to friends online while doing his homework (I like to think they are discussing the subject matter), suggesting that in the future synchronous written communication may be much more widely used (texting).

ASSESSMENT

Some of my students submit their portfolio cases via email or on disc. These are used for formative rather than summative assessment. Formative assessment of the progress of students through an elearning course can be monitored in a number of ways from time logged on to the website to accessing of modules. Summative assessment in the computer world of ''right and wrong'' (1 or 0) can most easily be carried out by multiple choice questions (MCQs), including extended

Creating an educational website

Web pages are written in HTML (click ''View'' then ''Source'' in the toolbar next time you access a web page for an example). Web pages are best written using an HTML editor (for example, Dreamweaver or Frontpage), but even quite dynamic pages can be constructed and linked using a word processing package (for example, Microsoft Word) which allows files to be saved as web pages (in HTML). (Use ''Web Page Wizard'' to get you started). HTML is a way of displaying content. An HTML page can then call a CSS file which tells it how to display (font size, highlighted headings, colours, etc). The separation of content from presentation is important, especially when considering multiple platforms. Interactivity is only possible using ''point and click'' hyperlinks but pages can easily be enriched by linking multimedia files (picture, videos, etc). To make the pages more ''interactive'' more programming skill is required. Many pages on the internet use Javascript for this which is embedded in the HTML code. Alternatively some freeware is available to facilitate this in the learning context (for example, Moodle—www.moodle.org). To produce really interoperable, accessible and durable RLOs you need expert help from the IT department and the backing of an organisation. However, it is possible to create some pretty impressive and useful learning resources with the simple programmes mentioned above.

As with all learning aids, there are a number of rules akin to the need to write legibly on the blackboard and restrict the number of lines on a PowerPoint slide. So if you really want to get started open Microsoft Word, click on ''File'', ''New'', ''Webpages'', ''Web Page Wizard''... but remember the following points.

- Pages will display differently in different browsers and different screen sizes: if you have a state of the art monitor your students may not. Some browsers do not support certain fonts—use a widely available one and choose one that is easy to read (for example, Verdana, Helvetica or Arial).
- Users of elearning like instant results: slow download times (large files) and passwords discourage use. One solution is to put content on a disc and give it to students. If you want to monitor their progress ask them to go online periodically to allow their computer to synchronise with yours. Students will also be put off by clicking through multiple pages to find what they want—have a site map and index, preferably with a search tool.
- Remember cognitive load: we can all remember about seven things at one time. If your learner has to work out where to go, which link to use and worry about scrolling down to find something they will find it harder to learn. Good websites can be used intuitively (www.usability.gov). Look at sites you have visited and enjoyed and then ask one of your children, or your friend's children, to look at what you've done.
- As with all teaching media do not overload with content: too much text is off-putting and difficult to read, use a sans serif font, keep sentences short and punchy; ''chunk'' information; consider a glossary or the use of hyperlinks to allow more in-depth study.
- Use established educational principles: allow learners who want an overview to get one and those that want a step by step guide to follow it logically; problem based learning is popular at present, offer it as an alternative or even primary choice.
- Be a good mentor: if your students want to elearn then allow them to email you with queries or, if possible, arrange a face to face meeting to review progress; consider a blog or virtual group. Allow learners time to study on your site as with any other medium. On the site provide scaffolding to support learning (for example, glossary or subject specific terms; the option to click an icon beside a chest *x* ray to get the radiologists' report, or access a tutorial on how to read a chest *x* ray; perhaps provide the option of a senior opinion at decision points in a virtual case).
- Use the medium to enrich the learner's experience as much as possible (patient videos, animation, pictures, *x* rays, laboratory results, referral letters, ECGs, etc), but don't let these distract learners from your message. (Don't forget confidentiality and consent). Remember there may be some benefit from providing information in multiple formats (text, pictures and audio) to increase learning or simple appeal to different learning styles.
- Where possible, try to be interactive (not just active) to stimulate learning—back to problem based learning again.

matching, ''n-from-many'', etc. More sophisticated assessments might include the use of a virtual patient either as a ''multimedia enhancement'' with subsequent MCQs or a genuine diagnostic reasoning problem. In the latter the problems of multiple correct scenarios arises. In the past a ''consensus based'' scoring system has been used for images in membership examinations in which marks were weighted towards the answer given by the most ''experts''. A similar model could be applied to the progress of a candidate through a virtual case.

HOW IS IT DONE?

The information (text, pictures, videos, etc) is stored in a data repository. Data repositories are linked to each other and to users to form a federation. In the context of teaching the content can be managed and accessed by a learning management system. This is software that allows the teacher to create content, the learner to access it, and the administrator to monitor the process. A variety of these are available from freeware to fully supported commercial systems. The teacher can also monitor students' progress and provide reminders if they are not progressing as expected. (This is sometimes referred to as ''nagware'').

The ''holy grail'' of elearning is the ability to use and reuse the RLO (reusable learning object). This might be a video or perhaps a piece of text that could be used in a number of settings: case scenario, skills teaching, virtual tutorial, examination, multimedia adjunct to a real tutorial. With many subject experts creating their own content there are many different formats necessitating the agreement of an industry standard. A format called XML is generally favoured. However, the important thing is the ability to label RLOs so that users (both teachers and subsequently their learners) can access

elearning resources

Programming/web design

- Johnson S. *Brilliant FrontPage 2003*. Pearson, Prentice Hall, 2003. How to make the most of Microsoft FrontPage when creating web pages
- http://www.htmldog.com/ Tutorials on HTML programming
- Castro E (ed). *HTML: Visual Quickstart Guide*, 5th ed. Peachpit Press, 2003. How to programme in HTML
- http://www.webmonkey.com/ Thau's Javascript Tutorial is very helpful
- http://www.usability.gov/ Evidence based website design
- http://moodle.org/ A free learning management system.
- http://uk.groups.yahoo.com/ To create discussion groups.

General computer knowledge

- Levine J, Bardoudi C, Young M. The Internet for Dummies, 8th ed. Hungry Minds, 2002.
- http://en.wikipedia.org/wiki An online encyclopaedia of everything but particularly everything you wanted to know about computer terms and abbreviations (although some are apparently written by those in the know for those in the know). NB. This is a wiki and if you really want to change an entry you can!

Teaching concepts

- http://www.learningandteaching.info/ An online site explaining more or less everything you wanted to know about teaching and learning. There is an extensive bibliography.

elearning

- http://www-jime.open.ac.uk An on-line journal with many free articles on elearning and teaching

them. Hence this is probably akin to the Mac/PC debate rather than an all or nothing struggle for mutually exclusivity (for example, VHS/Betamax videos).

Within such a system a subject expert can draw up a learning resource (tutorial/case etc) in a predefined pattern and populate it with multimedia resources as appropriate. A content engineer can then convert it to the correct format. User (teacher) friendly software to create learning modules is slowly becoming more easily available. Once in the correct format it is easy to store, access and, importantly now, convert to different platforms (palmtop, laptop, mobile phone, etc). Once in place, learners can access the RLOs in a way they choose (for example, holistic, stepwise, problem based, etc). The buzzwords are ''reusable'', ''interoperable'', ''accessible'' and ''durable''.

DOES IT WORK?

> ''The proof of the pudding is in the eating.'' Cervantes, circa 1600

A number of studies comparing elearning to more traditional methods have been carried out. Based on these it can be concluded that it is another useful tool in the teaching toolbox.[1] It is not a panacea but neither should it be dismissed as a passing ''fad''. Just like non-electronic teaching methods it has its strengths and weaknesses (one would rarely use a lecture to teach a surgeon to operate or a number of parallel small group tutorials to give a standardised overview of a subject). Some learners find it useful, some less so, just as some learners enjoy interactivity and some prefer a more passive approach. As with most teaching modalities, deep rather than superficial learners appear to enjoy the greatest benefit.[2 3] A number of studies show positive learner perceptions.[4 5] Comparison with more ''traditional'' teaching is unhelpful. The future is to look at what elearning can do and use it to its strengths; elearning is good for ''just in time learning'' and ''just for me'' (''in my own time'') learning, assuming I (the learner) find it a medium from which I can learn. It crosses geographical boundaries and time zones and provides access for the learner to a wealth of resources beyond those which he or she can easily access in his or her home institution. The challenge for teachers is to fill data repositories with useful, accessible RLOs and help learners access the full richness of the medium.

Beware! Developing elearning is addictive.

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